ROCKY FLATS PLANT, NON-NUCLEAR PRODUCTION FACILITY
(Building 44) (Plant A) (Building 444)
South of Cottonwood Ave., west of Seventh Ave. & east of bldg. 460
Golden vicinity
Jefferson County
Colorado

HAER No. CO-83-L

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PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
National Park Service
1849 C St. NW
Washington, DC 20240

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HISTORIC AMERICAN ENGINEERING RECORD

ROCKY FLATS PLANT,
NON-NUCLEAR PRODUCTION FACILITY HAER No. CO-83-L
(Rocky Flats Plant, Building 444)
(Rocky Flats Plant, Plant A)
(Rocky Flats Plant, Building 44)

Location:	Rocky Flats Environmental Technology Site, Highway 93, Golden, Jefferson County, Colorado. Building 444 is located south of Cottonwood Avenue, directly east of Building 460, and west of Seventh Avenue.
Date of Construction:	1953.
Fabricator:	Austin Company, Cleveland, Ohio.
Present Owner:	United States Department of Energy (USDOE).
Present Use:	Depleted Uranium Manufacturing.
Significance:	This building is a primary contributor to the Rocky Flats Plant historic district, associated with the United States (U.S.) strategy of nuclear military deterrence during the Cold War, a strategy considered of major importance in preventing Soviet nuclear attack. Building 444, one of the first four buildings constructed at the Rocky Flats Plant (Plant), was the primary non-nuclear manufacturing facility. Manufacturing processes in this building fabricated weapons components and assemblies from a variety of materials, including depleted uranium, beryllium, stainless steel, aluminum, and vanadium. Building 444 remained in production until 1994.
Historians:	D. Jayne Aaron, Environmental Designer, engineering-environmental Management, Inc. (e²M), 1997. Judith Berryman, Ph.D., Archaeologist, e²M, 1997.

Project Information:

In 1995, an inventory and evaluation was conducted of facilities at the Rocky Flats Plant for their potential eligibility for listing in the National Register of Historic Places. The primary goal of this investigation was to determine the significance of the Cold War era facilities at the Plant in order to assess potential effects of the long-term goals and objectives of the USDOE. These goals and objectives have not yet been formalized, but include waste cleanup and demolition activities. Recommendations regarding National Register of Historic Places eligibility were developed to allow the USDOE to submit a formal determination of significance to the Colorado State Historic Preservation Officer for review and concurrence and to provide for management of historic properties at the Plant.

From this determination and negotiations with the Colorado State Historic Preservation Officer, the Advisory Council, and the National Park Service, a Historic American Engineering Record Historic American Engineering Record project began in 1997 to document the Plant's resources prior to their demolition. The Plant was listed on the National Register of Historic Places in 1997. The archives for the Historic American Engineering Record project are located in the Library of Congress in Washington, D.C.

Introduction:

The Plant was one of thirteen USDOE facilities that constituted the Nuclear Weapons Complex, which designed, manufactured, tested, and maintained weapons for the U.S. arsenal. The Plant was established in 1951 to manufacture triggers for use in nuclear weapons and to purify plutonium recovered from retired weapons. The trigger consisted of a first-stage fission bomb that set off a second-stage fusion reaction in a hydrogen bomb. Parts were formed from plutonium, uranium, beryllium, stainless steel, and other materials.

A tense political atmosphere both at home and abroad during the Cold War years drove U.S. weapons research and development. By the 1970s, both the U.S. and the Soviet Union maintained thousands of nuclear weapons aimed at each other. These weapons were based on submarines, aircraft, and intercontinental ballistic missiles. Both the North Atlantic Treaty Organization and Warsaw Pact countries in Europe had small nuclear warheads known as theater weapons used as part of the Mutually Assured Destruction program. (The Mutually Assured Destruction program acted as a deterrent in that if one side attacked with nuclear weapons, the other would retaliate and both sides would perish.) The final nuclear weapons program at the Plant was the W-88 nuclear warhead for the Trident II missile. This mission ended in 1992 when President Bush canceled production of the Trident II missile.

The Plant was a top-secret weapons production plant, and employees worked with a recently man-made substance, plutonium, about which little was known concerning its chemistry, interactions with other materials, and shelf life. The Historic American Engineering Record documentation effort focused on four aspects of the Plant and its role in the Nuclear Weapons Complex; manufacturing operations, research and development, health and safety of workers, and security.

Chronology of Building 444:

1951 Construction began on Building 444.

1953	Manufacturing operations began. Historic names include Building 44 and Plant A. Initial manufacturing operations were devoted to the manufacturing of depleted uranium weapons components.
	Building 446, a guard post associated with the non-nuclear manufacturing complex, was completed.
1954	Beryllium research and development scale operations began in Building 444.
1955	Radiography vaults were added to Building 444.
1956	Building 447 was added to the southwest corner of Building 444 to provide manufacturing space, an assembly area, and a waste processing area. Heat furnaces were installed to anneal depleted uranium parts.
1957	Building 445 was added to the east side of Building 444 to house the carbon shop, which supplied graphite molds and crucibles to Building 444 and 776 foundries, and the graphite storage and cutting areas.
	Building 883 was constructed. Uranium ingots were cast in Building 444, transferred to Building 883 for further processing, then returned to Building 444 for final machining.
1958	Building 450, an exhaust plenum, was completed. Full-scale beryllium fabrication (machining) operations began. AeroTech® ventilation systems were installed at each machine.
1960s	Beryllium operations included casting and shaping.
1962	Building 448 was added to the north side of Building 447 to house production control activities for the 444 Complex. Beryllium wrought process (casting and forming) was developed.
1964	Installation of a central AeroTech® system in the basement of Building 444 replaced the initial ventilation system.
1966	Uranium-niobium alloying research and development began, using an electron beam furnace.
1967-68	Zero Power Plutonium Reactor Project began.
1969	Building fire (depleted uranium).

1973	Building 453, used for storage of tools, fabricated weapon parts, and raw materials, was completed.
1974	AeroTech® system replaced with an overhead duct system, external chip cyclone, and a high efficiency particulate air filter in the exhaust systems.
1975	Building 457, used for graphite storage, was completed.
Mid-1970s	Full-scale production of uranium-niobium alloys began after the installation of an arc furnace.
1976	Beryllium was supplied from off-site contractors; foundry casting (wrought process) ceased.
1980	Foundry cleaned of all beryllium; associated equipment removed.
1981	Production plating laboratory became operational.
1986	Beryllium ventilation system was upgraded to include two sets of high efficiency particulate air filters and high and low vacuum systems for fines and heavier particulates.
1987	Titanium stripping operations began.
1989	Uranium foundry was shut down.
1990	A fire occurred in the coating room of the production plating lab; plating laboratory was shut down.
1992-4	Process operations were ceased.
1993	Building awaited decontamination and decommissioning.

<u>Building History:</u>

Originally called Plant A, Building 444 was one of the first buildings constructed at the Plant. Building 444 was the primary non-nuclear manufacturing facility at the Plant. Manufacturing processes completed in this complex were used to fabricate weapons components and assemblies from a variety of materials, including depleted uranium, beryllium, stainless steel, aluminum, and vanadium.

The production equipment located in Building 444 was used to support war reserve, special orders work, and manufacturing development. Operations included casting, machining, heat treating, welding, brazing, chemical milling, plating, coating, and testing and inspection of weapons components made of depleted uranium, depleted uranium composites, beryllium, stainless steel, and ferric metals. Each material required different processing techniques.

When expansion of the Plant, called Part IV, took place in 1956 and 1957, additions were made to Building 444. The expansion was motivated by changes in trigger design and subsequent increased fabrication requirements.

Building Description:

Building 444 is constructed of poured, reinforced concrete. A portion of the building has a second floor and a basement (112,900 square feet on the ground floor; 23,700 square feet in the basement; and 25,400 square feet on the second floor and mezzanines). Design elements include cast-in-place concrete superstructure with interior columns, exterior walls with monolithic columns, and elevated floor and roof slabs with monolithic beams and girders. Additionally, some of the interior firewalls are reinforced concrete with monolithic columns.

The roof is flat with short parapet walls. Roofing is built-up over rigid insulation with gravel ballast. The exterior walls initially had window openings. With the exception of a lunchroom, the wall openings are covered with asbestos-cement sheets or filled with concrete masonry units. Interior partition walls are concrete masonry units or gypsum board. In special environmentally controlled areas, interior partition walls are composite laminates with rigid insulation panels. Bridge cranes and monorails were installed throughout Building 444; most are out of commission.

Within Building 444, there are three designated areas: the open access area, the radiological control area, and the beryllium control area. The open access area was not subject to any administrative controls. The radiological control area was a management control area, within which personnel were required to wear personal protective equipment to shield against radiation exposure, and dosimeters to record radiation exposure. Over half of the original building is contained within the radiological control area. There are no physical barriers between the open access area and the radiological control area. The smallest designated area is the beryllium control area. This area is equipped with separate ventilation control systems to control the release of beryllium dust. This area is separated from the others by physical barriers.
The original building area contains a foundry and numerous shops and laboratories. Shops within the original portion of the building include depleted uranium, beryllium, and carbon (graphite) machine shops, and heat treating, coating, tool grinding, welding and brazing, and building maintenance shops. A portion of the precision shop is also housed in this building.

Laboratories include pressure and leak-testing, plating, precision measuring, and non-destructive testing laboratories. Some of the former shop areas have been converted into storage areas for excess tools and materials.

Two x-ray vaults and a portion of the precision shop are located west of the original portion of Building 444. The walls of the x-ray vaults are 4'-thick concrete with labyrinth-type entryways. The tops of the vaults are open to the building roof.

The remaining portions of the precision shop and the calibration laboratory are located west of the x-ray vaults. Construction and design elements include reinforced-concrete exterior walls and steel interior columns and roof framing. Three below-grade utility tunnels run north-south beneath this area.

Rooms 180C and 179, located on the southern side of the western end of the building, are oil storage areas. Rooms 180C and 179 are additions to the original building configuration. Room 179 is within the radiological control area.

A receiving and stock storage area for the precision shop, Room 148C, is located on the north side of the building. Mechanical utility equipment is stored immediately west of Room 148C, in Room 148D.

The area east of the original portion of Building 444 was open, with a rail spur alongside the building. This area was later enclosed to contain an inspection laboratory for the tool grind shop, a tool storage room, and a corridor.

The open access side of Building 444 houses the tool and gauge shop, the tool grind shop, the erbia coating lab, a carbon shop, and administrative areas. Specialized graphite molds and crucibles needed in the foundry were produced in the carbon shop. The tool and gauge, tool grind, and carbon mold producing shops supported plant-wide manufacturing efforts.

The building utility systems include process and domestic water, process and sanitary waste, and air supply and exhaust systems. Plant air, house vacuum, instrument air, steam heating, and cooling water systems are contained within the building. Most of the utility systems have been significantly upgraded since the original construction of the building. All mechanical and electrical utility equipment is contained in the basement or on the roof. A grid of lightning rods and ground cables provide lightning protection.

The beryllium machining area is equipped with specialized ventilation equipment that has undergone several replacements. When beryllium operations first began in 1958, this ventilation equipment consisted of AeroTech® cyclone separator units placed at each machine to filter airborne beryllium at the point of generation. These units' exhausts were connected to the main building exhaust that served the uranium areas. This first system was replaced in 1964 by a central AeroTech® system which was connected to the main building exhaust. This second system was arranged so that each machine's local ventilation went through a drop box to collect heavier debris, through the central plenum, and finally through a single bank of high-efficiency particulate air filters prior to exhaust. The AeroTech® system was replaced in 1974. The replacement system consisted of an overhead duct system that led to an external chip cyclone and a high-efficiency particulate air filtration unit. This system was upgraded again in 1986 to include two stages of high-efficiency particulate air filtration. This last and final upgrade included two types of conveyance systems: a low-vacuum system to carry fine particulates, and a high-vacuum system to carry heavier particulates.

Building Complex
Building 444 is part of the non-nuclear manufacturing complex. Buildings associated with the non-nuclear manufacturing complex include Building 427, an emergency generator; Building 446, a guard post; Building 445, carbon storage; Building 447, manufacturing of depleted uranium; Building 448, depleted uranium material storage; Building 449, carpenter and paint shop storage; Building 450, an exhaust plenum; Building 455, a plenum; and Building 453, a storage area. Buildings 445 and 447 are pre-engineered, single-story metal buildings attached to Building 444. The complex, as a whole, covers 178,340 square feet, of which 35,200 square feet is open-access and 143,120 square feet is within a radiological control area.

The radiological control area portion of the complex includes part of Building 444 (108,800 square feet), Building 447 (25,820 square feet of floor space), and Building 448 (3,720 square feet of floor space). The radiological control area portions of the complex house equipment which was used for processing depleted uranium, beryllium, and other metals.

Building Operations:

Each operational area within Building 444 was designed to facilitate a systematic flow of material, primarily depleted uranium and beryllium. Building operations included foundry processes, fabrication and assembly of parts, testing and inspection of fabricated products, and support operations. Coating and plating operations were conducted on materials from Building 460 (outside the Building 444 flow of materials). Other operations within Building 444 included special projects.

Foundry Process
Depleted uranium ingots (arc-cast, induction cast, and alloys), beryllium ingots, and aluminum shapes were produced in the foundry.

Depleted Uranium Casting

During the initial research and development period (1951-55), depleted uranium was shipped to the Plant as derby-shaped parts from the Gaseous Diffusion Plant in Paducah, Kentucky and later as ingots from the Feed Materials Production Center in Fernald, Ohio. The Plant foundry cast ingots of depleted uranium from virgin depleted uranium, scrap depleted uranium, depleted uranium alloys, silver, aluminum, and copper. The metals were placed in crucibles, loaded into one of eight induction furnaces and melted in a vacuum atmosphere. Induction casting used radio frequency energy to melt the metal, which was poured into graphite molds to form ingots. Depleted uranium casting operations ceased in 1988.

Beryllium Casting

Casting of beryllium (beryllium wrought process) began in 1962, and involved a number of processes and buildings. Beryllium was received in the form of bar stock prior to development of the wrought casting process. The beryllium wrought process was a complicated process whereby beryllium ingots were cast in Building 444, then transferred to Building 881 to be canned (encased) in stainless steel (the canning process was used to aid the subsequent rolling process, as beryllium is very brittle). Canned beryllium was transferred to Building 883 to be heated and rolled to the required thickness. The stainless steel was cut away after rolling, and the resulting beryllium sheets were pressed into the required shapes, and transferred back to Building 444 for machining. The beryllium foundry ceased operation when the wrought process was discontinued in 1975, and was replaced by the purchase of sintered (pressed powder) beryllium blanks from off-site vendors.

Fabrication

Fabrication operations in Building 444 included machining of beryllium and depleted uranium. Tools used during machining operations included engine lathes, mills, turning and milling machines, electrical-discharge-machining equipment, and chemical-machining equipment. Individual machining operations were divided into two areas: beryllium and depleted uranium. A negative air pressure was maintained in fabrication areas to prevent the spread of contaminated dust into other areas.

Beryllium Fabrication

Beryllium machining operations were conducted on bar stock (1958-62), beryllium castings (1962-75), and sintered forms (1975-93). The machining process included sawing, milling, drilling and lathe operations. If needed, the pieces were then polished and abraded. Chemical milling of fabricated beryllium parts occurred in Room 203 of Building 444. Site returns (weapons returned to the Plant for reprocessing, upgrade, or retirement) that contained beryllium were returned to the Building 444 beryllium machining area to be dismantled. Beryllium machining operations continued until 1993. Ingots and semi-finished and finished beryllium parts were heat treated in the induction furnace located in Room 403 of Building 447.

Beryllium machining operations were conducted in isolated rooms containing independent air filtering systems. A number of systems have been used in Building 444 to filter airborne beryllium, to maintain a negative air pressure in the beryllium work areas, and to prevent the spread of beryllium dust.

Depleted Uranium Fabrication

Prior to the construction of Building 883 in 1956, final machining of depleted uranium took place in Building 444. After 1956, the uranium ingots were cut into slices (rolling pucks) in Building 444 and shipped to Building 883. There the pucks were rolled and formed into their initial shape and transported back to Building 444 for final machining.

Machining of depleted uranium was conducted in Room 101. Metal parts containing depleted uranium, depleted uranium alloy, and depleted uranium with traces of iron, silica, titanium, aluminum, or stainless steel were cut in the depleted uranium machining process. Machining operations included turning, facing, boring, milling, and sawing. Ingots and semi-finished and finished depleted uranium parts were heat treated in the induction furnace located in Room 403 of Building 447.

In 1956, the chip roaster in Building 447 became operational. Depleted uranium chips recovered from machining areas were collected in covered 55-gallon drums, transferred to Building 447, and burned to an oxide (a more stable form) under controlled conditions in the chip roaster. The oxides were packaged and shipped off-site for disposal.

Assembly

Assembly operations included cleaning, brazing, welding, assembly etching, metallic coating, weighing, and leak testing. Component parts and partially assembled weapon components (subassemblies) from Building 444 were shipped to the final weapon assembly areas (Buildings 991, 777, and 707, depending upon the time frame) for use in finished trigger assemblies. Weapons components and assemblies were also shipped directly to the Y-12 Plant located on the Oak Ridge Reservation in Tennessee and the Pantex Plant in Amarillo, Texas.

Uranium, beryllium, and stainless steel parts were cleaned prior to welding, brazing, and coating. Deionized water, isopropyl alcohol, ethyl alcohol, and Oakite® were among the materials used to clean fabricated parts.

During assembly parts underwent one or more welding or brazing operations. Assembly welding processes included tungsten inert gas, electron beam, and tungsten inert gas crimp welding, and electron bombardment and vacuum furnace brazing. Materials welded included beryllium parts, depleted uranium, and other source materials.

The electron beam welder joined parts made of beryllium with parts made of other materials. The brazing operations used rings and wires of various filler metals and a flux to join like and unlike materials. Electron bombardment brazing was conducted using a bell jar and vacuum pump arrangement. Vacuum furnace brazing was performed in a furnace chamber.

Assembly etching was performed prior to assembly coating. Uranium parts were acid etched using an ultrasonic etching bath. Subsequently, uranium parts were coated with silver using a hot-hollow cathode chamber and titanium vapor deposition coatings were applied using a vacuum coating chamber.

Testing and Inspection

In-process and final inspections were performed for quality assurance on all products generated in the Building 444 complex. This included special order and regular production components, subassemblies, graphite molds, and cutting tools from tool grinding. Inspection equipment included fixed, open setup, and machine gauging. Testing and inspection activities included assembly testing, non-destructive testing, and product inspection.

Assembly testing

Assembly testing included a variety of operations to determine product integrity and conformance to design specifications. Test procedures included one or more of the following: leak and pressure tests, weight determination, crimping or swaging, and electromarking.

Non-Destructive Testing

Test methods included radiography, ultrasonic inspection, weight and density measurement, and dye penetrant inspection. Radiographic testing (also referred to as beta back scattering) used x-rays to detect internal flaws (i.e., cracks, lack of fusion, and inclusions) in parts and subassemblies. Ultrasonic inspection (also referred to as eddy current inspection) was used to detect voids and other defects in welded joints of parts and subassemblies. Dye penetrant testing used dye penetrant oil to detect surface cracks and other defects in parts and subassemblies.

Product Inspection

Product inspection, used to provide quality assurance for parts fabricated in the building or purchased off-site, consisted of a series of cleaning and non-dimensional inspection processes to determine the dimension of machined parts and conformance to design specifications.

Coating and Plating

Coating and plating operations were performed on non-nuclear parts such as stainless steel and copper. These parts were not fabricated in Building 444, rather, they were fabricated in Building 460 (stainless steel and non-nuclear component manufacturing).

Coating

Non-nuclear parts fabricated in Building 460 were coated with erbium oxide. In preparation for coating, the parts were grit-blasted, ultrasonically cleaned, rinsed, and dried. The parts were then coated with erbium nitrate, dried, and heat-treated. The heat-treating decomposed the erbium nitrate to erbium oxide. The spray and heat processes were repeated as necessary. Residual spray was removed using a silicon grit blast.

Plating

War reserve and special order parts fabricated from copper, steel, and stainless steel were etched and plated. Various plating tanks containing different plating solutions were used, including: silver plating, sulfuric etch, nickel plating, alkaline cleaner, and electroless nickel-plating tanks.

Support Operations

Non-production operations included production control, certification, tool engineering, tool grinding, tool/gauge fabrication (precision shop), tool and gauge inspection, development and application of plating techniques and materials, and graphite mold fabrication.

Special Projects

The Plant conducted special order work for other facilities in the weapons complex, the Department of Defense, or to fulfill the needs of other federal departments or agencies. Most of the special order work at the Plant did not involve materials outside those used in regular production activities. Most of the special order work was relatively short-lived. One exception to this was the Zero Power Plutonium Reactor project.

Zero Power Plutonium Reactor project

From 1967 to 1968, the Plant manufactured approximately 4,000 stainless steel-clad fuel elements consisting of plutonium, molybdenum, and uranium. The fuel rods were manufactured for installation in a reactor at Argonne National Laboratory. The Zero Power Plutonium Reactor fuel elements were manufactured by alloying uranium and molybdenum in Building 444. The alloy was then sent to Building 771, where it was alloyed with plutonium, and then clad in stainless steel envelopes in Building 776/777.

Other Special Projects

Other known special projects conducted in Building 444 included cadmium rolling and forming research and development operations; beryllium research and development work using tetrabromoethylene for float/sink tests from 1968 to 1972; and machining of lithium salts, using processes similar to those used in uranium machining.

Operations Since 1989

After nuclear weapons components production ceased at the Plant in 1989, fewer and fewer components were produced in Building 444 each year. Manufacturing continued in the building until 1994. By the end of 1994, Building 444 was idle, awaiting the decontamination and decommissioning process.

Sources: Colorado Department of Health. *Project Tasks 3 & 4 Final Draft Report. Reconstruction of Historical Rocky Flats Operations and Identification of Release Points (1992),* by ChemRisk. Rocky Flats Repository. Golden, Colorado.

Coven, Walter, employed at the Plant by the site contractor for 33 years. Personal communication, January 1998.

Swenson, Peter, employed at the Plant by the site contractor since 1982. Personal communication, December 1997.

United States Department of Energy. Public Affairs. n.d. *Rocky Flats Information. Nuclear Weapons Complex.* Golden, Colorado: U.S. Department of Energy, Office of Communications and Economic Development.

United States Department of Energy. *Final Site Safety Analysis Report - Building 444 (1982),* by Rockwell International. Rocky Flats Repository. Golden Colorado, 1982.

United States Department of Energy. *Historical Release Report (HRR) (1994),* by EG&G. Rocky Flats Plant Repository. Golden, Colorado, 1994.

United States Department of Energy. *Final Cultural Resources Survey Report (1995),* by Science Applications International Corporation. Rocky Flats Repository. Golden, Colorado, 1995.